PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Evaluate Spawning Of Salmon Below The Four Lowermost Columbia River Dams

BPA project number: 9900300
Contract renewal date (mm/yyyy): 10/1999 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Pacific Northwest National Laboratory

Business acronym (if appropriate) WDFW, ODFW, USFWS, PNNL

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
Sections 2.2A, 3.3, 3.3A.2, 3.B, 3.3D, 5.4A, 5.9A, 6.1A, 6.1C, 7.0D, 7.1, 7.1A, 7.1C, 7.1D, 7.1F, 7.5D.1, 7.6, 7.8G, 7.8J, 8.1, 8.1A.1, 8.1A.2, 8.1A.3, 8.4A, 8.4B.1, 8.4D, 8.4D.1, 8.4D.3, 9.1A

FWS/NMFS Biological Opinion Number(s) which this project addresses
NMFS ESA - Section 7 Biological Opinion on the reinitiation of consultation on 1994-1998 operation of the Federal Columbia River Power System and Juvenile Transport Program.

Other planning document references
Our proposal is designed to identify, preserve, and enhance naturally spawning anadromous fish and their habitat in the main stem Columbia River. This is consistent with goals put forth in the WDFW’s Wild Salmonid Policy and in Wa-Kan-Ush-Mi Wa-Kish-Wit. ISGs Return to the River discusses the importance of "populations spawning in large alluvial main stem reaches that may have function as critical populations". They

also state "it is important to consider small subunits of stock during management of river flows".

Short description
Monitor, protect, and enhance the spawning populations of fall chinook and chum below Bonneville Dam. Develop a habitat profile of the spawning and rearing area. Search for evidence of fall chinook spawning below The Dalles, John Day and McNary dams.

Target species
Fall chinook and chum salmon.

Section 2. Sorting and evaluation

Subbasin
Lower Mid-Columbia mainstem

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9600800	PATH	Provides additional data for analysis
8201300	Coded Wire Tag Recovery Program	Provides additional CWT recovery information

8810804	Stream-Net	Provides additional data to the anadromous fish data base (section 3.3B) and the Coordinated Information System (section 3.3A.2)
9602100	Gas Bubble Disease Reach and Monitoring of Juvenile Salmonids	Provides information relating to the operation of the hydrosystem
9602400	Changes in Gas Bubble Disease Signs & Survival of Migrating Juvenile Salmon	Provides information relating to the operation of the hydrosystem
9300802	Symtons of GBT Induced in Salmon by TDGS of Columbia and Snake rivers	Provides information relating to the operation of the hydrosystem
9701400	Evaluation of Juvenile Fall Chinook Stranding on the Hanford Reach	was in umbrella table
9801003	Monitor and Evaluate the Spawning Distribution of Snake River Fall Chinook	was in umbrella table
9406900	Spawning Habitat Model to Aid Recovery Plans for Snake River Fall Chinook	was in umbrella table

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1999	Document evidence of fall chinook spawning The Dalles, and John Day dams and chum below Bonneville Dam	yes
1999	Develop population estimates for fall chinook and chum spawning below Bonneville Dam	yes
1999	Marked redds for emergence sampling	yes
1999	Installed two water level reocrders/thermistors with remote communications in fall chinook and chum spawning areas.	N/A
1999	Measured microhabitat parameters for fall chinook and chum and recorded geographic locations of spawning areas and important hydraulic features.	yes
1998	Collected 100 (sampling goal) GSI sample from fall chinook spawning below Bonneville Dam	yes
1998	Developed model to provide spawning	yes

	and incubation flows for fall chinook and chum salmon spawning downstream from Bonneville Dam.	

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Search for evidence of fall chinook spawning below Bonneville, The Dalles, John Day, and McNary dams and chum spawning below Bonneville Dam.	a	Count live/dead fish by on-water observation
		b	Count redds by on-water observations.
		c	Record locations of redds on GPS
		d	Download GPS data onto GIS (Intergraph) maps
		e	Provide fish and redd count data to the Fish Passage Center each week for dissemination on their Homepage.
2	Profile adult populations spawning below the four lowermost dams for important biological and genetic characteristics	a	Examine carcasses for missing fin clips and collect snouts of adipose clipped (coded-wire tagged) fish.
		b	Annually, document the initiation, peak, and duration of spawning time by conducting annual redd counts.
		c	Annually, collect fork lengths by sex of carcasses to determine average size at return.
		d	Annually, determine sex ratio based on carcass sampling.
		e	Annually, determine egg retention by examining female carcasses and estimating the number of remainig eggs.
		f	Annually, collect scales and determine age composition by scale reading analysis.
		g	Use adult or juvenile tag rates to

			determine stock origins based on CWT recoveries.
		h	Continue to collect GSI and DNA tissue samples until the sampling goal of 100 per each pool and species is achieved.
		i	Perform genetic baseline anylysis to determine the relative uniqueness of this stock. At a future date, DNA samples will be used to help determine the possible heritage of this stock.
3	Develop and improve population estimates for fall chinook and chum spawning below Bonneville Dam.	a	Using underwater video system define areas where habitat characteristics (e.g. substrate, depth, velocity, slope) appear suitable for spawning.
		b	Expand current sampling areas to identify other possible spawning locations .
		c	Count shallow water redds by on-water and deep water redds by underwater observations.
		d	Record redd locations using GPS.
		e	Collect habitat variables (near-bed velocity, depth, and dominant substrate size) for each redd.
		f	Estimate redd densities and total number of redds.
		g	Compare spawning habitat available to habitat used as a function of total river discharge.
		h	Count live and dead fish by on-water investigations.
		i	Tag and recapture carcasses.
		j	Estimate the total spawning

			population by two methods - carcasses capture-recapture and fish per redd.
		k	Develop expansion factors to estimate for future population sizes based on live/dead fish counts or shallow water redd counts under various flow conditions.
		l	Use annual age and stock information collected to establish a data base for run reconstruction and run prediction for this stock.
4	Profile juvenile fall chinook and chum for important biological and genetic characteristics.	a	Piezometers will be installed in spawning areas below Bonneville Dam prior to and/or during the spawning adults.
		b	Measurements of water surface elevation, temperature, electrical conductivity, and dissolved gas will be taken at least once per month during the incubation interval (October through May).
		c	Individual piezometers may be instrumented with pressure/temperature loggers to monitor changes in these parameters over different discharge levels.
		d	Annually, calculate temperature units to estimate possible emergence.
		e	Install emergence traps and record beginning and ending of emergence dates for all redds sampled to verify actual emergence.
		f	Attempt to determine any differences between estimated and actual emergence. Possible differences may be environmental variables including redd locations, ground water temperatures, river flows, hyphoric characteristics, etc.
		g	When emergence is complete, excavate redd to enumerate

			unhatched eggs.
		h	Collect juvenile fall chinook and chum in Hamilton slough (below Bonneville Dam) with a stick or beach seine on a weekly basis.
		i	Sample catch for species composition, fin marks, and average fork lengths.
		j	Record and track catch rates and size of juvenile chum and fall chinook.
		k	Attempt to identify any relationships that may exist between emigration time and size vs environmental factors (i.e. flow, temperature, etc.) using hydraulic models developed in Objective 7.
		l	Determine origins of fish captured by collecting GSI, DNA tissue or fin samples from a subsample of the catch.
		m	Determine level of interaction between outmigrating hatchery smolts and rearing juveniles.
5	Determine extent of stranding of juvenile chum and fall chinook below Bonneville Dam and the association with flows from Bonneville Dam.	a	Record number of juvenile chum and fall chinook stranded in shallow water areas in Hamilton Sough (below Bonneville Dam) on a weekly basis.
		b	Examine stranded juveniles for indications of GAS bubble trauma.
		c	Measure and record physical and water chemistry features from entrapments.
		d	Determine specific elevations of entrapment areas and relate to Bonneville Dam discharge history through use of hourly discharge records and the hydraulic simulation model.
6	Further investigations of the feasibility of marking juvenile fall chinook produced below Bonneville Dam to determine juvenile to adult survival rates.	a	CWT a limited number of juvenile fall chinook collected Objective 4(h) that are of adequate size.

		b	Based on the sampling results from Objective 4(h), determine if the fish captured are the target species, fish produced from natural spawners below Bonneville Dam.
		c	Determine the number of fish needed to be CWT to determine juvenile to adult survival rates.
		d	Determine whether adequate numbers of juvenile can be captured and CWT marked.
7	Construct hydraulic models for chum and fall chinook spawning and rearing below Bonneville Dam.	a	Cross sections will be selected to characterize habitat and hydraulic conditions. Data collections will consist of field measurements of physical parameters including water depth and velocity, substrate type, and water temperature.
		b	Establish reference marks and cross sections.
		c	Cross sections profiles and water surface elevations will be referenced to real elevations.
		d	A reference cross section will be established in the Columbia River main channel downstream from Bonneville Dam and upstream from the Ives/Pierce/Hamilton Island complex for calibration of a ratio.
		e	Build and calibrate hydraulic models for main channel and off channel spawning and rearing areas.
		f	Use and unsteady river flow and water quality computer models to determine the effects of ocean tides on Columbia River hydraulics downstream of the Bonneville Project.
8	Determine flows required to protect spawning and rearing fish for spawning year 1999 and make findings readily available to managers.	a	Install remote water level recorders and temperature monitors in chum and fall chinook spawning areas
		b	Real time monitoring of river elevations in spawning areas to ensure redds are not dewatered

		c	In season analysis based on level recorder data and hydraulic models.
		d	Water depth and flow data provided each week to the Fish Passage Center for dissemination on the Homepage.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	12/1999	Evidence (redds or fish) of fall chinook spawning below Bonneville, The Dalles, John Day, and McNary dams and chum spawning below Bonneville Dam.		10.00%
2	10/1999	2/2000	Profile adult populations spawning below the four lowermost dams for important biological and genetic characteristics.		5.00%
3	10/1999	1/2000	Develop and improve estimates for fall chinook and chum spawning below Bonneville Dam.		25.00%
4	10/1999	9/2000	Profile juvenile fall chinook and chum for important biological and genetic characteristics.		25.00%
5	5/2000	8/2000	Determine extent of stranding of juvenile chum and fall chinook and the association with flows from Bonnevile Dam.		5.00%
6	5/2000	9/2000	Further investigate feasibility of CWT marking juvenile fall chinook below Bonneville Dam.		5.00%
7	10/1999	9/2000	Construct hydraulic models that profile flows below Bonneville		15.00%

			Dam.		
8	10/1999	9/2000	Determine flows required to protect redds and rearing fish below Bonneville Dam.		10.00%
				Total	100.00%

Schedule constraints
ESA permits, bad weather; atypical hydrograph; unknown complexity associated with the required level of spacial resolution and accuracy for tidal analysis; insufficient numbers of data points for habitat use resulting from lack of fish/ poor conditions.

Completion date
Except for a few objectives that will be finished, annual funding is expected to be required.

Section 5. Budget

FY99 project budget (BPA obligated): $220,269

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	WDFW Vanc. $31,924 WDFW Kenn.$8,766 ODFW $45,970 USFWS $29,678 PNNL $42,643	%41	158,981
Fringe benefits	WDFW Vanc. $6,138, WDFW Kenn. $3,082 ODFW $16,549 USFWS $8,780 PNNL $7,807	%11	42,356
Supplies, materials, non-expendable property	WDFW Vanc. $4,700 WDFW Kenn. $0 ODFW $21,400 USFWS $500 PNNL $6,830	%9	33,430
Operations & maintenance	WDFW Vanc. $13,731 WDFW Kenn. $0 ODFW $0 USFWS $4,500 PPNL $0	%5	18,231
Capital acquisitions or	WDFW Vanc. $0 WDFW Kenn $0,	%0	0

improvements (e.g. land, buildings, major equip.)	ODFW $0 USFWS $0 PNNL $0		
NEPA costs	WDFW Vanc. $0 WDFW Kenn $0, ODFW $0 USFWS $0 PNNL $0	%0	0
Construction-related support	WDFW Vanc. $0 WDFW Kenn $0, ODFW $0 USFWS $0 PNNL $0	%0	0
PIT tags	# of tags: 0	%0	0
Travel	WDFW Vanc. $4,100 WDFW Kenn $500, ODFW $3,000 USFWS $6,870 PNNL $15,764	%8	30,234
Indirect costs	WDFW Vanc. $13,330 WDFW Kenn $2,470, ODFW $30,856 USFWS $11,072 PNNL $14,064	%19	71,792
Subcontractor	Associated Western Universities	%5	18,764
Subcontractor		%0	0
Subcontractor		%0	0
Subcontractor		%0	0
Other	WDFW Oly GSI Analysis (Adults)	%3	12,000
		TOTAL BPA FY2000 BUDGET REQUEST	$385,788

Cost sharing

Organization	**Item or service provided**	**% total project cost (incl. BPA)**	**Amount ($)**
		%0	
		%0	
		%0	
		%0	
		Total project cost (including BPA portion)	$385,788

Outyear costs

	FY2001	**FY02**	**FY03**	**FY04**
Total budget	$403,805	$423,995	$445,195	$467,454

Section 6. References

Watershed?	**Reference**
☐	Carlson, C., and Mike Dell. August 1992. Vernita Bar Monitoring For 1991-1992. Annual Report. PUD of Grant County.
☐	Hymer, J. April 1997. Results of Studies on Chinook Spawning in the Main Stem Columbia River below Bonneville Dam. Columbia River Progress Report #97-09. Washington Department of Fish and Wildlife. Battle Bround,

	Washington.
☐	Dauble, D.D. and D.G. Watson. 1997. "Status of fall chinook salmon populations in the mid-Columbia River, 1948-1992. North American Journal of Fisheries Management 17:283-300.
☐	Dauble, D.D., R.L. Johnson, R.P. Mueller, C.S. Abernethy, B.J. Evans and D.R. Geist. 1994. Identification of fall chinook salmon spawning sites near lower Snake River hydroelectric projects. Prepared for the U.S. Army Corps of Engineers, Walla Walla.

PART II - NARRATIVE

Section 7. Abstract

The primary focus of this project is to determine what conditions must exist to provide successful spawning and rearing below main stem dams and what measures must be taken to protect those fish. Goals and objectives for this project in FY2000 are three fold; (1) continue to learn more about naturally reproducing populations of fall chinook and chum that currently exist below Bonneville; (2) collect, summarize, and analyze the data so that the effects of the hydrosystem can be better understood and managed in a manner to protect and benefit naturally reproducing populations; (3) and verify the existence or absence of spawning populations below The Dalles, John Day, and McNary dams.

The NWPPC has placed a high priority on the protection and enhancement of naturally spawning populations in the main stem Columbia River as evidenced in Measure 7.1C. In addition, BPA is directed through the NMFS ESA Section 7 Biological Opinion to evaluate the affect of power peaking operations on juvenile and adult salmon passage and on the river ecology downstream of Bonneville Dam.

The methods suggested in this project have been successfully used in other areas of the Columbia River. Those methods include total population estimates generated by carcass tagging and recapture plus fish per redds, spawning habitat requirements profiled in the Snake River and Hanford Reach, stranding locations of juvenile salmonids identified in the Hanford Reach, emergence timing, seining and CWT marking juvenile fall chinook in the Hanford Reach, the effects of unsteady water flows in the Hanford Reach, stock identification using GSI or DNA, and quantification of habitat use and availability in the Hanford Reach and middle Snake River.

Several objectives and tasks are expected to be completed in FY2000, some need to be continued past FY2000, while others need to be conducted annually. The future expected outcome of this project is to determine what makes the spawning population successful below Bonneville Dam and are there naturally reproducing populations below the other three upstream dams (The Dalles, John Day, and McNary). If spawning populations are found below the upstream dams, portions of the study targeting on the population below Bonneville Dam would be extended upstream where new populations are documented.

The results will be monitored in-season by contact with the various agencies including via the Internet and post season in wrtitten reports.

Section 8. Project description

a. Technical and/or scientific background

Historically, fall chinook were known to spawn in the main stem Columbia River where adequate habitat existed; however, with the development of the region, hydroelectric facilities built along the length of the Columbia River inundated the majority of the spawning habitat in the main stem. Currently, the free flowing stretch of river between McNary and Priest Rapids dams contains the vast majority of the spawning habitat in the Columbia River. A significant self-sustaining population of wild fall chinook does use and depend on this stretch of the Columbia River for spawning and rearing purposes (Dauble and Watson, 1997).

Similar type habitat may exist below other main stem Columbia River dams and self-sustaining populations may exist in these areas also. Currently, there has been little or no effort to determine if fall chinook are spawning in the main stem Columbia River from McNary Dam downstream.

Fall chinook and chum salmon spawning in the main stem Columbia River just below Bonneville Dam have been documented in recent years (Hymer, 1997). Limited pawning ground surveys have been conducted in the area around Ives and Pierce islands during 1994-1997. This spawning ground data suggests a naturally reproducing populations of both fall chinook and chum salmon exist in the area and that spawning may occur from mid-October through mid-December with the peak spawning time likely being the first half of November. Limited sampling of adult carcasses has occurred and surveys have been inadequate for purposes of estimating spawning population size. Additionally, no data have been collected concerning juvenile production or habitat characteristics of these spawning and rearing locations.

Though not currently documented, similar fall chinook spawning populations may also exist below The Dalles, John Day, and McNary dams. It was suspected and anecodotal information suggests that a self-sustaining fall chinook population currently exists in the area just below John Day Dam. It is well documented that this area was a productive main stem spawning area prior to the construction of John Day Dam and it is likely that at least a portion of these displaced fish would have finally taken up residence just below the dam after their historic spawning grounds were inundated. A similar situation may have also occurred below The Dalles and McNary dams.

In recent years it has become apparent that a self-sustaining spawning population of fall chinook and chum exists just below Bonneville Dam, primarily near Ives and Pierce islands. It has also become apparent that flunctuating flows may be negatively impacting this population through redd dewatering, lack of access to prime spawning and rearing areas, and the possible stranding of juveniles. Additionally, it became apparent that data concerning this population was necessary to determine how flows and temperatures might affect this population and to develop management plans to protect these stocks. Finally, fall chinook fisheries management under ESA requires accountability of all fall chinook stocks returning to the Columbia River.

b. Rationale and significance to Regional Programs

The Northwest Power Planning Council's Independent Scientific Advisory Board and other salmon managers have placed a high priority on the protection and enhancement of naturally spawning populations, including fall chinook and chum spawning in the main stem Columbia River. This is evidenced by Measure #7.1C "collection of population status, life history, and other data on wild and naturally spawning populations" of the Fish and Wildlife program.

Spawning of chum and fall chinook in the main stem Columbia River has been documented just below Bonneville Dam. Spawning may also be occurring just below The Dalles, John Day, and McNary dams. Currently very little is known about the existence and/or size of these populations, their associated genetic composition, spawn timing, emergence timing, juvenile rearing duration, and juvenile to adult survival rates.

This project will provide base-line information that will improve management of wild and naturally spawning stocks, develop long term monitoring strategies, and more specifically to provide base-line information necessary for managing naturally producing fall chinook that may currently exist below the four lowermost Columbia River main stem dams.

Measure 7.0D is the comprehensive environmental analysis of federal production activities. The programmatic Environmental Impact Statement is designed to assess the impacts on naturally produced salmon with fish being introduced from federally funded hatcheries in the Columbia River Basin. The U.S. Fish and Wildlife Service will be evaluating hatchery practices in response to this concern. The juvenile portion of this study will determine if interaction occurs between outmigrating hatchery produced salmonids and naturally produced fish rearing just downstream from Bonneville Dam.

This project will also provide data to the anadromous fish data base (section 3.3B) and the Coordinated Information System (Stream Net, section 3.3A.2). Data provided will be used to annually update and enhance information in the stock summary reports. In turn, stock summary reports are used to provide information on program implementation, performance standards, harvest, and stock status. Currently, Stream Net does not include any information concerning fall chinook and chum populations spawning in the main stem Columbia from McNary Dam downstream.

Measure 7.1A is the evaluation of carrying capacity. Implementing the ecosystem approach will require knowledge of the Columbia River ecosystem. Bonneville and federal agencies will evaluate salmon survival in the Columbia River, its estuary, and in near-shore ocean response. This project provides a unique opportunity to collect life history information and estimate juvenile to adult survival rates for naturally produced fall chinook.

Systemwide and cumulative impacts of existing and proposed artificial production projects is the goal of Measure 7.1F. This measures states that studies will be designed that evaluates impacts of artificial production activities on ecology, genetics, and other important characteristics for Columbia River Basin anadromous and resident fish. Additionally, methods for assessing impacts from proposed new artificial production projects will be developed. This project will provide data necessary for determining if main stem fall chinook and chum are impacted by current hatchery practices.

Additionally, this project will provide data that will allow development and/or re-evaluation of management goals, spawning ground escapement objectives, and improve statistical quality of run forecasting. These goals are listed in Measure 7.1F to develop harvest goals and escapement objectives. The data from this project will contribute to revision of Columbia River Fish Management Plan and PFMC's Salmon Plan to protect and account for needs of Columbia and Snake River salmon and populations, including those listed by ESA.

Measure 5.1D.4 is designed to evaluate alternative ramping rates for flow fluctuations at main stem Snake and Columbia River dams to constrain reductions and increases in total flow per 24-hour period at these projects. Additionally, The Bonneville Power Administration is directed through the National Marine Fisheries Service Endangered Species Act – Section 7 Biological Opinion on the Reinitiation of Consultation on 1994-1998 Operation of The Federal Columbia River Power System and Juvenile Transportation Programs as such: "Beginning in 1995, BPA will evaluate the affect of power peaking operations on juvenile and adult salmon passage and on the river ecology downstream of Bonneville Dam and on the Hanford Reach, downstream of Priest Rapids Dam. Contingent on the results of these evaluations, BPA will develop a plan to decrease power peaking operations from mid-March through mid-December on the lower Snake and Columbia Rivers (page 162, #11).

This project will provide information releative to the impacts of load following activities at Bonneville Dam on the river ecology, and reproductive success and rearing of fall chinook and chum in the Columbia River below Bonneville Dam.

c. Relationships to other projects

This project can be linked to several other projects. One such project is the BPA CWT Recovery Project. CWT recoveries from the areas below the four lowermost main stem Columbia River dams would help complete accountability of Columbia River fall chinook which is critical to developing accurate annual run size estimates. Biological and mark sampling data is used by managers for Columbia River fall chinook run reconstructions and run size predictions. Each year since 1980 a subcommittee of senior biologists from WDFW, ODFW, and USFWS, and Columbia River Technical Advisory Committee have used this information to make Columbia River fall chinook final forecasts. It is important to note that currently fall chinook spawning below Bonneville Dam are not tagged with CWTs and therefore are not represented in current run reconstruction techniques and harvest management scenerios.

The PATH Project also benefits from this project. PATH determines the conversion rates between Columbia River dams. This model depends upon complete fall chinook accountability, because fish that are unaccounted for are assumed to be the result of inter-dam losses. If populations of fall chinook do exist below Bonneville, The Dalles, John Day, and McNary dams, and are not accounted for then PATH'S estimates of inter-dam losses may be inaccurate. The PATH model also depends on data concerning juvenile fall chinook, including juvenile to adult survival rates. Data collected by this project concerning juvenile fall chinook would allow biologists to better define parameters used in PATH and Life Cycle Models.

The BPA funded Stream Net Project also benefits from this project. Data collected from this project could be directly incorporated into the StreamNet data base. Data collected from both the adult and juvenile portions of this project would be useful to Stream Net users.

This project is also related to the BPA Project that is developing a spawning habitat model to aid in recovery plans for Snake River fall chinook salmon. PNNL is leading a study looking at the spawning habitat requirements of fall chinook salmon in the Hanford Reach of the Columbia River. Results of this study are being used to develop recovery plans for Snake River fall chinook salmon.

The evaluation of juvenile fall chinook stranding in the Hanford Reach is also related to this project. PNNL is assisting WDFW in developing a conceptual stranding model for juvenile fall chinook salmon. This includes the unsteady flow and GIS modeling.

d. **Project history** (for ongoing projects)

FY1999 was the initial year of funding for this project. Field studies began in October 1998. Spawning surveys, redd counts, GPS mapping, and habitat use data collection were all initiated in October. Remote water level recorders were installed in spawning areas in late October-early November. At the time this proposal was written, spawning surveys and habitat use data collection for fall chinook was nearly complete and surveys for chum were still on-going.

e. Proposal objectives

Objective 1 – Document Existing Populations: Determine if fall chinook are spawning below Bonneville, The Dalles, John Day and McNary dams and if chum are spawning below Bonneville Dam. Document number of fish and redds observed at each location and record and map location of each redd observed.

Products: Documentation of existence or absence of spawning populations of fall chinook below the four lowermost Columbia River dams and chum below Bonneville Dam.
Annual counts of fish (live and dead) and redds observed.
GIS map of redd locations below each project.

Objective 2 – Profile Adult Populations: Profile populations using important biological characteristics and determine genetic heritage of populations existing below four lowermost Columbia River dams. Sample carcasses to recover biological information concerning stocks and perform genetic analyses (GSI or DNA) to identify genetic heritage of each existing populations. Determine estimates of spawning timing, duration, and peak; age specific size at return; sex ratios; age composition; and egg retention rates for each population.

Products: Annual estimate of initiation, duration, and peak of spawning time for each population.
Estimates of annual size at return, sex ratios, age compositions, and egg retention rates for each population.
Genetic base-line data.
Populations location on a genetic map including other west coast chinook and chum populations.

Objective 3 – Estimate Spawning Population Sizes: Develop and improve estimates of number of fall chinook and chum spawning below Bonneville Dam. Expand sampling areas to include deep water redds and other possible spawning locations. Determine total area with suitable spawning habitat and total number of redds in that area. Compare redd distribution to total available habitat and attempt to relate habitat usage to Bonneville Dam discharge. Develop expansion factor that will allow shallow water redd counts to accurately index total redd counts in future years. Incorporate improved run size estimates into fall chinook run reconstruction data base.

Products: Annual estimate of fall chinook and chum redds below Bonneville Dam.
Annual population estimates for fall chinook and chum spawning below Bonneville Dam.
Predicted or "available" spawning habitat for chum and fall chinook below Bonneville Dam.
Map of redd locations, including elevation, and fall chinook and chum spawning areas below Bonneville Dam.
Any relationships that exist between fall chinook and chum redd distribution and Bonneville Dam discharge history.

Expansion factors necessary for estimating spawning population sizes in future years.

More complete accounting of fall chinook run sizes for use in run size forecasting.

Objective 4 – Profile Juvenile Populations: Profile populations using important biological characteristics and determine its genetic heritage. Determine emergence timing, length of residency, and emigration size and time for fall chinook and chum rearing below Bonneville Dam. Relate these biological characteristics to environmental variables, including discharge, river elevation, depth, hyporheic flow, temperature, and redd location. Data collected and models developed under objective 7 will be used to evaluate these relationships. Perform genetic analyses (GSI or DNA) to identify genetic heritage of each existing population and level of interaction between outmigrating hatchery smolts and rearing juveniles.

Products:

Annual estimates of number of unhatched eggs observed per redd; beginning and ending emergence dates; emigration size; rearing duration; and beginning and ending emigration dates for chum and fall chinook rearing below Bonneville Dam.

Monthly estimates of water surface elevation, temperature, electrical conductivity and dissolved gas associated with fall chinook and chum redds below Bonneville Dam.

Any relationships that exist between enviromental factors and biological characteristics.

Genetic base-line data.

Populations location on a genetic map including other west coast chinook and chum populations.

Objective 5 – Juvenile Stranding: Determine extent of stranding of juvenile chum and fall chinook below Bonneville Dam (in Hamilton Slough) and relate stranding observations to Bonneville Dam discharge history. Measure and record physical and water chemistry features associated with power peaking events and examine stranded fish for indications of gas bubble trauma.

Products: Weekly estimates of the number of juvenile fall chinook and chum stranded in Hamilton Slough.

Any existing relationship between Bonneville Dam operations and stranding event.

Weekly estimate of stranded juenile suffering from gas bubble trauma.

Objective 6 – Marking Juvenile Fall Chinook: Further investigate the feasibility of CWT marking naturally produced juvenile fall chinook rearing below Bonneville Dam for the purpose of determining juvenile to adult survival rates. Determine number of fish to be tagged and feasibility of capturing and tagging that number of fall chinook.

Products: Number of fish to be tagged to accurately estimate juvenile to adult survival rates.

Written assessment of the feasibility of capturing and marking juvenile fall chinook below Bonneville Dam.

Objective 7 – Construct Hydraulic Models: Develop hydraulic models that profile flows, elevations, and velocities in areas below Bonneville Dam used by fall chinook and chum for the purposes of spawning and rearing. Incorporate unsteady flow models to account for tidal effects on Columbia River hydraulics downstream of Bonneville Dam.

Products: Hydraulic flow model that estimates specific flows, river elevations, and water velocities in spawning and rearing areas below Bonneville Dam under various Bonneville discharge levels.
Unsteady river flow model that incorporates the effects of ocean tides on river hydraulics below Bonneville Dam.

Objective 8 – Minimum Flows: Record instantaneous flows and temperatures in fall chinook and chum spawning and rearing locations below Bonneville Dam and weekly disseminate information through The Fish Passage Center homepage. Monitor flows in season to ensure that redds are not dewatered.

Products: Weekly updates of instantanuous flows and temperatures in chum and fall chinook spawning and rearing areas.
Real time flow updates.

f. Methods

This project is primarily composed of three closely related activities. Each agency is responsible for one activity with WDFW leading the adult portion, ODFW leading the juvenile portion, and the USFWS leading the habitat portion of this project. All three portions of the project are designed to work together to achieve the objectives of this project and each agency took the lead on a portion of this project based on their special skills and/or knowledge in those areas. PNNL will provide technical support to all three portions of this project.

Surveys to identify and enumerate shallow water redds and recover carcasses will occur weekly below each project during mid-October through mid-December. Prior to peak spawning time surveys will occur twice a week below Bonneville Dam to more accurately identify the onset of spawning. Number of redds, live and dead fish (by species) observed will be recorded using GPS for transfer to GIS for purpose of developing maps depicting redd distribution below the four lowermost Columbia River dams.

Carcasses recovered during surveys will be sampled for biological data, including sex, length, scales, and eggs remaining in carcass. Carcasses recovered below Bonneville Dam will be marked with a plastic colored tag for identificaion purposes when recovered later. Any recoveries of tagged carcasses will be noted. Using the Worland technique, the number of carcasses recovered will be used to estimate the total spawning population. The spawning population size will also be estimated using a fish per redd ratio.

PNNL will expand redd count to include deep water redds, for the purposes of estimating the total number of redds present below Bonneville Dam. PNNL will survey fall chinook and chum salmon spawning areas in the main stem Columbia River downstream of Bonneville Dam, note individual redd locations, and deliniate the areas used for spawning. Initial search areas wll be determined using existing bathymetric data, data on known spawning areas (Hymer 1997), and results of FY1999 studies. Line transects will then be established at regular intervals and visual images of redds and bottom substrate will be recorded using an underwater video system according to procedures described in Dauble et. al. (1994). Deep-water surveys will be conduced immediately after the peak spawning interval (i.e. mid-November to early-December). The objective in FY2000 will be to document the presence or absence of redds in locations where observations from a boat are not possible (i.e. depths >4 ft.). The location of redds will be determined using a GPS receiver. Relative precision of positional data will be based on fixed geo-referenced points obtained at Bonneville Dam and is expected to be within 0.5 m. The total area used for spawning (including inter-redd space) will be delineated and spatial extent estimated. This information will be used to develop a detailed sampling design for population inventory studies planned for FY2001.

Specific habitat variables to be collected for individual redds will include near-bed velocity, depth, and dominate substrate size. Velocity data will be collected using a Marsh McBirney Flow-Mate flowmeter attached to a camera sled. Substrate images will be analyzed in the laboratory using OPTIMUS software. All redds, reference targets, and survey locations would be geo-referenced using GPS and map layers will be created using GIS (Intergraph) techniques.

Hydraulic data collection will be completed for off-channel and main channel cross sections that were selected to characterize habitat and hydraulic conditions in spawning and rearing areas downstream from Bonneville Dam. Field measurements of cross section profiles including horizontal distance, water depth, and water column velocity will be collected using an acoustic Doppler current profiler, bottom substrate will be classified visually, or with an underwater video system, cross section and water surface elevations will be measured with an electronic total station and referenced to real elevations, and water temperature will be recorded with thermographs installed throughout the spawning and rearing areas**.** We will continue to accumulate data points for the reference cross section in the Columbia River main channel downstream from Bonneville Dam, and upstream from the Ives/Pierce/Hamilton Islands complex for calibration of a rating curve, and as a reference point for quantification of the tidal effect on water surface elevations.

Measured hydraulic field data will be used along with output from the MASS models on the effect of the tides on water surface elevations, to calibrate hydraulic simulation models that will be used to characterize physical and hydraulic parameters over a wide range of flows. Habitat modeling will be conducted using hydraulic simulations together with habitat suitability criteria to determine the relationship between river discharge and the quantity and quality of spawning and rearing habitat. Data collection will continue for habitat used by fall chinook and chum salmon. Observations of depth, velocity, substrate, and cover will be made in spawning and rearing areas. Existing habitat suitability criteria will be reviewed and we will determine whether the existing criteria can be modified, or if new relationships are required.

Remote, recording water level and temperature monitors will be installed in known fall chinook and chum salmon spawning areas downstream from Bonneville Dam. Real-time water temperature and depth or elevation data will be provided to the Fish Passage Center for dissemination on their Internet Homepage. In-season analyses will be conducted as requested using real-time data along with hydraulic models to determine the effect of Bonneville discharge on spawning fish and redds. Streamflows will be determined that will protect spawning fish from October through December, and redds through emergence of fry.

An unsteady river flow and water quality computer model(s) will be used to determine the effects of ocean tides on Columbia River hydraulics downstream of the Bonneville Project. For the past several years, Modular Aquatic Simulation Systems (MASS) models have been used successfully to model unsteady flow and flood profiles of the Hanford Reach; flow and sediment transport in the Lower Sanke River under natural river conditions (drawdown); and temperature and dissolved gas modeling in the Lower Columbia and Snake rivers. As part of these projects, the models have been designed, applied, and calibrated to account for the tidal influence downstream of the Bonneville Project.

Piezometers will be installed in spawning areas below Bonneville Dam prior to and/or during the salmon spawning season. Piezometers may consist of perforated steel pipe (dia. approx. 4 cm.) or of a drive-point consisting of polyethylene tubing. Installation of piezometers will be performed using a jack hammer or by hand, depending on site-specific conditions. The specific locations and spatial distribution of piezometers will be determined following site review. Piezometers will be installed in clusters of two to three individual piezometers with each piezometer installed to a different depth below the river bed. A surveyor will be used to record the piezometer location and elevation. Measurements of water surface elevation, temperature, electrical conductivity, and dissolved gas will will be taken from piezometer and contiguous river. Samples will be taken at least once per month during the incubation interval (October through May). Individual piezometers may be instrumented with pressure/temperature loggers in order to monitor changes in these parameters over different discharge levels. Statistical comparisons of piezometer data using analysis of variance (or other techniques) will be used to evaluate the relationship between hyporheic characteristics and emergence timing as well as to evaluate effects of spill and ocean tides on intragravel water quality conditions.

During weekly spawning ground surveys fall chinook and chum redds will be marked for later emergence sampling. Several redds will be selected based on location and depth. Redds will be chosen from various locations and at various depths to obtain a random sample of emergence timing for the entire spawning popuation. Emergent traps will be installed prior estimated time of onset of emergence (based on thermal units) and will be checked at regular intervals (Carlson and Dell, 1992). Onset and completion dates of emergence will be noted. After emergence is completed redd will be excavated to search for any unhatched eggs.

Regular surveys will occur to determine if fall chinook and chum are being entrapped below Bonneville Dam. Surveys will be coordinated with discharge reductions from Bonneville Dam when entrapments are most likely to occur. Number of fish entraped will be enumerated by species and discharge levels at which entrapments occurred will be recorded. All fish observed during entrapment surveys will be measured and examined for gas bubble trauma.

Juvenile seining will occur on a weekly bases beginning in mid-April and continuing until fish emigrate out of Hamilton Slough. Depending on the area being sampled, either a stick or beach seine will be used. All juveniles colected will be enumerated by species, measured, and examined for missing fins. A minimum of 100 fall chinook and 100 chum will be sampled for tissue samples for the purpose of performing GSI or DNA analyses. Genetic samples will be collected throughout the breadth of juvenile rearing period.

MASS models are physics-based; unsteady flows in rivers and canals is simulated by solving the equations of mass and momentum conseration. Standard model output consists of either average cross-sectional values (one-dimensional) or lateral distributions of depth-averaged values (two dimensional) for the following hydraulic components: discharge, water surface elevation, velocity, temperature, dissolved gas concentration, depth, area, hydraulic radius, channel top width, friction slope, and average sheer stress. These outputs can be further analyzed to compute additiional information such as water particle travel time and bed sheer stress. At each step,(or inter multiples of the time step) the user can specify model outputs at a given point or along a series of points. Thus the user can produce time series plots of water discharge and elevation at a given location or plots of water surface elevation versus river mile at a specific time. In the two-dimensional model, the user can also produce plots of the lateral distribution of variables. Data collected from hydraulic cross-sections and from water level recorders will be used to further calibrate the models. Output from the models will be provided to USFWS as needed for quantifying spawning and rearing habitat of fall chinook and chum salmon.

g. Facilities and equipment

WDFW personnel for the adult and juvenile studeis (except the stranding study) would be stationed at the Vancouver office. A jet sled would be rented from WDFW. Railings are attached on the front of the boat for on-water observations. This boat has been used in a multitude of adult and juvenile studies on the main stem Columbia and its tributaries.

WDFW is currently evaluating juvenile fall chinook stranding in the Hanford Reach of the Columbia River in collaboration with other fisheries research groups. Field work began in 1997 and is scheduled to be concluded in 1999. Transfer of personnel, equipment, and technology from the Hanford Project to the Ives and Pierce islands areas can be accomplished in year 2000 and will allow a comprehensive cost/effective assessment of juvenile salmonid stranding in the area below Bonneville Dam.

All ODFW employees will be stationed out of the Clackamas or Portland offices. All employees are provided office space, computers, support staff, and other office supplies to complete this project.

A four wheel drive truck is needed to haul personnel and the boat during the adult and juvenile studies. The truck will be rented from WDFW or ODFW.

Two jet sleds will be leased from USFWS. Custom modifications to these boats have been made to expedite hydraulic data collection in riverine environments.

USFWS will implement an Acoustic Doppler Current Profiler (ADCP) purchased by BPA from a previos project. ACDP's are state of the art instruments in hydraulic data collection, saving time and money. Hand held flow meters will be used to collect data in situations unsuitable for the ACDP such as in shallow redds. An electronic total station will be used to calculate and map physical habitat parameters. Thermographs will be placed in the study area.

A FishEye, wide angle, low light underwater video camera with laser calibration system will be used for substrate classification. The system is deployed using a 24-volt electric winch and davit assembly and images can be viewed on a video monitor, recorded on a VCR, or viewed with a portable computer with video capture software.

Precision Lightweight GPS Receivers will be available for geo-referencing physical data and fish and redd locations. The receivers use the NAVSTAR Precise Positioning System and are capable of real-time autonomous position within 4m.

List of equipment PNNL currently has available for use on the task to map fall chinook and chum spawning areas at no cost to BPA includes:

Sony camera in waterproof housing w/underwater cable, portable manual winch w /14 channl slip-ring assembly, video recording system, two video monitors, GPS, Monark boat w/ twin outboards, Echo sounder, flow meter, portable turbifimeter, personal computers, and GIS work station.

List of equipment currently available for use on the task to evaluate the effects of interstitial flow pathways on the water quality conditons in fall chinook and chum salmon redds downstream of Bonneville Dam:

Four-wheel drive pick-up, Piezometer installation system (air compresor, jack hammer, hoist, and other misc. tools), GPS, water quality monitoring instruments, remote data loggers, and GIS.

h. Budget

The WDFW, ODFW, and USFWS budgets remain relatively stable from FY1999 The overall budget increased in FY2000 because new activities are proposed (i.e., intragravel gas measurements, redd mapping, and genetic analyses on juvenile fall chinook and chum) and because staff from PNNL are included for technology transfer. Cost have been reduced by sharing of equipment and personel with other ODFW and WDFW field projects.

To complete the task to evaluate the effect of ocean tides on the hydraulic conditions downstream of the Bonneville Dam Project is estimated to cost $29,950. To complete the task of mapping fall chinook and chum salmon spawning areas will cost an estimated $25,917. A lot of the equipment is currently available and is listed above.

To complete the task to evaluate the effects of interstitial flow pathways on the water quality conditions in fall chinook and chum redds downstream of Bonneville Dam is estimated to cost $50,000.

For purposes of claculating the budget for this task, it was assumed that WDFW/ODFW would supply a technician to assist in piezometer installation and in sampling the piezometers. For piezometer installation, this would involve a continuous one-week period during September or October. For sampling PNNL staff would lead the sampling effort but a technician from WDFW/ODFW will be necessary to transport PNNL staff to the study location and assist in sampling. Sampling will be done monthly from October through May and is assumed to take no more than one day each month. A lot of the equipment is currently available and is listed above.

The estimated cost for the juvenile stranding study is $14,818.

Section 9. Key personnel

Joe Hymer
Fish and Wildlife Biologist 3
Pacific States Marine Fisheries Commission
FTE Hours – 0.2

EDUCATION A.S. Fish and Wildlife   Grays Harbor College 1980

Nineteen years of service for Washington Department of Fish and Wildlife/Pacific States marine Fisheries Commission on fishery management and research programs. Eighteen years experience on Columbia River data collection and fisheries management. Exensive experience in data collection, coordination, summarization, analysis. Joe has designed and planned numerous research activies. Joe was involved with the “discovery” of fall chinook spawning below Bonneville and John Day dams. Extensive experience capturing wild fall chinook with stick and beach seines on the Hanford Reach and Lewis River CWT projects.

EXPERIENCE

1981-present: Pacific States Marine Fisheries Commission. Responsible for planning and supervising the daily activities related to the recoveries of CWTs from the Washington side of the Columbia River. Previous duties included extensive involvement in CWT analysis used for fall chinook run reconstruction and run predicitons. Have personally collected biological and mark sampling data from the main stem Columbia and its tributaries from the mouth upstream to the Okanogan River in Canada. Since the early 1980s, have been involved in the capturing and tagging of wild juvenile fall chinook on the Hanford Reach and/or Lewis River.

RELEVANT PUBLICATIONS

Hymer, J. April 1997. Results of Studies on Chinook Spawning in the Main Stem Columbia River below Bonneville Dam. WDFW Progres Report # 97-9. Washington Department of Fish and Wildlife. Battle Ground, Washington.

Hymer, J. June 1993. Washington Columbia River and Tributaries Stream Survey Sampling Results 1992. WDFW Progress Report #93-19. Washington Department of Fisheries. Vancouver Washington.

Hymer, J., R. Pettit, L. Harlan, and R. Roler. February 1997. Run Size and Forecast of the Return of Columbia River Fall Chinook Salmon Stocks in 1997. WDFW Progress Report #97-05. Washington Department of Fish and Wildlife. Battle Ground, Washington.

PROJECT RESPONSIBILITIES

Joe will be the lead investigator on the adult sampling portion of this project. One his primary task will be to apply the modified tag and recovery model to determine the total population estimate. Joe will also be involved in the coordination of sampling with other agencies and the report writing/editing.

Patrick A. Frazier
Oregon Department of Fish and Wildlife
Fish Division
Columbia River Management, Clackamas

EDUCATION B.S. Fishery Science Oregon State University 1981

SUMMARY OF QUALIFICATIONS

Eighteen years of service for Oregon Department of Fish and Wildlife on fishery management and research programs, including five years on the Rogue River research project and 13 years with the Columbia River Management group. Considerable experience in management and sampling of commercial and sport fisheries.

EXPERIENCE

1996-present Assistant Project Leader (SFWB), Columbia River fisheries management program, Clackamas, Oregon.

1994-1996 Project Leader (FWB-3), Columbia River commercial sampling program, Clackamas, Oregon.

1989-1993 Project Leader (FWB-2), Columbia River commercial sampling program, Clackamas, Oregon.

1986-1989 Staff biologist (FWB-1), Willamette River spring chinook statistical creel programs. Clackamas, Oregon.

1983-1986 Project Assistant (EBA & EBA-1), Rogue River Research Study. Corvalis, Oregon.

Extensive experience with both commercial and sport fishery sampling programs. Participated at all levels of sampling programs from actual field sampling positions to supervisory program leader positions.

Duties have not been limited to fishery sampling programs. Pat has performed and used a variety of statistical methods to develop run size forecasts, performs run reconstructions, determine the status of salmonid stocks being reviewed for possible ESA listings, determine fallback rates at Snake River dams, determine the effects of environmental factors on growth and survival rates of Rogue River chinook.

Prior to joing the Columbia River Management program, Pat worked on the Rogue River research project. Field duties for this project included juvenile beach seining, adult beach seining, and spawning ground surveys.

PROJECT RESPONSIBILITIES

Pat will be the lead investigator on the juvenile sampling portion of this project. One his primary tasks will be to determine if sufficient numbers of naturally produced juvenile fall chinook can be captured below Bonneville Dam to be CWT. Pat will also be involved in the coordination of sampling with other agencies and the report writing/editing.

Donald R. Anglin
Fishery Management Biologist
U.S. Fish and Wildlife Service

EDUCATION B.S. Wildlife and Fisheries Management and Biology
Humboldt State University 1975

EMPLOYER AND RELEVANT EXPERIENCE

Mr. Anglin has been responsible for the Instream Flow section within the Habitat and Natural Production section at the Columbia River Fisheries Program Office of the U.S. Fish and Wildlife Service since 1988. He supervises three full time employees, supports administrative functions, and manages budgets for approximately $400,000 per year. He is technically responsible for study design, oversight of data collection, and analysis including, report production, proposal preparation, and technical assistance. Don is currently in the final stages of building a hydraulic model of the Hanford Reach of the Columbia River for white sturgeon habitat assessment. Other current responsibilities include:

•Instream Flow Studies - Columbia, Snake, Clark Fork Rivers. Target species; white sturgeon, fall chinook and chum salmon, rainbow trout.
•Water Rights Cases - Snake River for white sturgeon and nesting waterfowl
•Hydraulic modeling for island maintenance flows in the Snake River
•Minimum flow determination -fall chinook and chum salmon spawning in mainstem Columbia River.

Instream flow and habitat assessment studies conducted previously for the FWS have included:

•White Sturgeon Habitat Assessment (BPA 86-50) 1994-present.
•Klamath River Instream Flow Study. IFIM Scoping 1993-94. Target species: fall chinook, coho salmon, steelhead, green sturgeon.
•Water right quantification for Deer Flat NWR - Snake R. Islands Section.·Swan Falls Dam to Brownlee Pool-Approx. 120 miles 1992-present.
•Swan Falls Instream Flow Study-C.J. Strike Dam to Brownlee Pool, Snake R.-150 mi. 1988-92. Target species: white sturgeon, smallmouth bass, rainbow trout, mtn whitefish, channel and flathead catfish.
•Klickitat R. Instream Flow Study 1988-89. Target species: fall and spring chinook, coho, steelhead.

Instream flow and habitat assessment studies conducted previously from 1980-1988:

•Washington-Wenatchee, S.F. Skykomish Rivers; Skagit River drainage.
•Oregon-Sandy, Deschutes, Klamath, White Rivers; S.F. Mill Creek.
•Colorado-Colorado River, Elk Creek.
•New York-Hudson River, Black River.
•Target species: chinook, coho, sockeye, chum, pinks, steelhead, resident trout, walleye, smallmouth bass.
•Habitat suitability curve development for chinook, coho, pink, and chum salmon; steelhead.

SELECTED PUBLICATIONS

•Anglin, D.R. 1994. Report E *in* K. Beiningen, editor. Status and habitat requirements of white sturgeon populations in the Columbia and Snake Rivers upstream from McNary Dam. Annual Report to the Bonneville Power Administration (Project 86-50), Portland, Oregon.
•Annual Reports have also been produced for 1995, 1996, and 1997.
•Anglin D.R., Cummings T.R., Ecklund A. E. 1992. Swan Falls Instream Flow Study. 255 pp. U.S. Department of the Interior, Fish and Wildlife Service, Vancouver, Washington.
•Anglin, D.R. 1994. Lower Klamath River Instream Flow Study. Scoping evaluation for the Yurok Indian Reservation. 46 pp. For the Bureau of Indian Affairs, by U.S. Department of the Interior, Fish and Wildlife Service, Vancouver, Washington.
•Anglin, D.R. 1997. Quantification of white sturgeon habitat in the Columbia River Basin. Presentation at the White Sturgeon Summit, December 18,1997, Vancouver, Washington.

PROJECT RESPONSIBILITIES – 0.2 FTE

Determine sampling design for hydraulic and habitat models to characterize conditions for spawning and rearing fall chinook and chum salmon; supervise data collection using acoustic Doppler current profilers (ADCP), electronic total stations, GPS receivers, and underwater video; conduct and supervise data analysis for hydraulic and habitat modeling. Mr. Anglin is also responsible for budget management and report production.

David R. Geist
Battelle Pacific Northwest National Laboratory
Senior Research Scientist

EDUCATION B.S. Biology Eastern Washington University 1984
M.S. Biology Eastern Washington University 1987
Ph.D. Fisheries Science Oregon State University 1998

EMPLOYER AND EXPERIENCE

Dr. Geist is a Senior Research Scientist in the Ecology Group at Battelle, Pacific Northwest National Laboratory. He has been with Battelle since 1991 and has extensive experience and expertise in the ecology of Pacific Northwest fishes, especially fall chinook salmon in the Columbia River Basin. Dr. Geist's current research involves developing and testing a conceptual spawning habitat model that describes the importance of landscape processes in determining utilization of spawning areas by fall chinook salmon. This includes the role of hyporheic flow on spawning site selection by fall chinook salmon. Dr. Geist is a member of the American Fisheries Society and American Institute of Fishery Research Biologists. Recent research activities include:

Lead scientist and project manager for several projects addressing environmental monitoring and technology applications, including investigating habitat utilizatin, bioenergetics, and migration behavior of fall chinook salmon in the Columbia River.

Studying ground-water /surface-water interactions and contaminant movement in slamon spawning areas in the Hanford Reach and Snake River.

Modeling impacts of hydropower system operations on resident fish in the Upper Columbia River, including Lake Roosevelt; and participating in planning and evaluation activities of salmon supplementation in the Yakima and Klickitat rivers.

SELECTED PUBLICATIONS

Geist, D.R., M.C. Joy, D.R. Leem and T. Gosner. 1998. “A Method for Installing Piezometers in Large Cobble Bed Rivers”. Ground Water Monitoring and Remediation 17:78-82.

Geist, D.R., and D.D. Dauble. 1998. “Redd Site Selection and Spawning Habitat Use by Fall Chinook Salmon: the Importance of Geomorphic Features in Large Rivers.” Environmental Management 22:655-669.

Geist, D.R., D.D. Dauble, and R.H. Visser. 1997. The development of a spawning habitat model to aid in recovery plans for Snake River fall chinook salmon.” Fiscal Year 1995 and 1996 Progress Report to the Bonneville Power Administration, Portland, Oregon.

Geist, D.R., L.W. Vail, and D.J. Epstein. 1996. “Analysis of Potential Impacts to Resident Fish from Columbia River System Operation Alternatives.” Environmental Management 20:275-288.

PROJECT RESPONSIBILITIES

Dr. Geist will serve as the principle investigator for the characterization of hyporheic conditions (0.1 FTE). His primary responsibilities will be to ensure task milestones are met on time and within budget; develop experimental study plan for the hyporheic task; coordinate his activities with regional agencies and tribes; and supervise staff in field work and data analysis for the hyporheic task.

Dennis D. Dauble
Battelle Pacific Northwest National Laboratory
Techncial Group Manager

EDUCATION B.S. Fisheries Oregon State University 1972

M.S. Biology	Washington State University 1978
Ph.D. Fisheries	Oregon State Univerisity 1988

EMPLOYER AND EXPERIENCE

Dr. Dauble has been a staff member at Battelle, Pacific Northwest Laboratory since 1973. He is currently a Staff Scientist and Technical Group Leader for the Ecology Group. Dr. Dauble regularly interacts with state and federal regulatory and management agencies in issues relating to regional impacts of power plants, hydroelectric facilities, and other energy-develop,emt activities on anadromous and resident fishes.

Dr. Dauble has considerable expertise in activities related to impacts from hydropower generation and flow regulation on anadromous salmonids. For example, he served on regional committees and directed studies to evaluate potential impacts of drawdown and other operational scenarious on anadromous fish survival. He also provided assistance to the Snake River Recovery teanm on the passage and survival of Endangered Speices Act salmon stocks. Dr. Dauble was involved in salmonid enhancement efforts in the Yakima River Basin, including coordination of environmental review activities anong the science and policy teams for the project. On-going studies focus on characterizing habitat requirements of fall chinook salmon in mid-Columbia and lower Snake rivers which involve the use of aerial photography, stream mapping, and geographic information system (GIS) techniques. He recently synthesized 45 years of data on factors influencing the abundance of fall chinook salmon populations in the Hanford Reach.

Dr. Dauble is a member of the American Fisheries Society, the Ecological Society of America, the Northwest Scientific Association, the Pacific Fishery Biologists, and is a Fellow in the American Institute of Fishery Research Biologists. He is also an adjunct professor at Washington State, Oregon State, and Central Washington State universities.

SELECTED PUBLICATIONS

Dauble, D.D., R.L. Johnson, and A. Garcia. In Press. Fall chinook spawning in the tailraces of lower Snake River hydroelectric projects. Transactions of the American Fisheries Society.

Dauble, D.D. and D.G. Watson. 1997. “Status of fall chinook salmon populations in the mid-Columbia River, 1948-1992. North American Journal of Fisheries Management 17:283-300.

Dauble, D.D., R.L. Johnson, R.P. Mueller, C.S. Abernethy, B.J. Evans and D.R. Geist. 1994. Identification of fall chinook salmon spawning sites near lower Snake River hydroelectric projects. Prepared for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

Dauble, D.D., J.R. Skalski, A.E., Giorgi, and A. Hoffman. 1993. Evaluation and application of statistical methods for estimating smolt survival. DOD/BP-62611-1. Prepared for Bonneville Power Administration, Portland, Oregon.

Dauble, D.D., and R.P. Mueller. 1993. Factors affecting the survival of upstream migrant adult salmonids in the Columbia River basin. Recovery issues for threatened and endangered Snake River Salmon. Technical Report 9 of 11. Prepared for Bonneville Power Administration, Portland, Oregon.

Dauble, D.D., T. L. Page, and R.W. Hanf, Jr. 1989. "Spatial distribution of juvenile salmonids in the Hanford Reach, Columbia River". Fishery Bulletin 87(4): 775-790.

PROJECT RESPONSIBILITIES

Dr. Dauble will serve as lead investigator (0.05 FTE) for the deepwater redd surveys and spawning delineation activity. His primary responsibilities will be to advise and particpate with other staff on experimental design, implementation of fieldwork, and data analysis and reporting.

Marshall Richmond
Battelle Pacific Northwest National Laboratory
Senior Research Engineer

EDUCATION

B.S. Civil and Environmental Engineering Washington State University 1982
M.S. Civil and Environmental Engineering Washington State University 1983
Ph.D., Civil and Environmental Engineering University of Iowa 1987

EMPLOYER AND EXPERIENCE

Dr. Richmond rejoined Battelle Pacific Northwest Laboratory in 1994 as a Senior Research Engineer in the Hydrology Group. His professional experience includes basic and applied research, university teaching, and project management. His principle areas of expertise are in the development and application of computational model of hydrodynamics,sediment transport, and contaminant transport in environmental systems, physical modeling of hydraulic structures, fisheries engineering, and turbulence model in computational fluid dynamics. Dr. Richmond is the developer of the MASSI (Modular Aquatic Simulation System) one-dimensional and MASS-2 two dimensional hydrodynamics and water quality computer models. He is also leading the development of an individual model for fish called FINS (Fish Individual-based Numerical Simulator). Selected experience includes the following:

Unsteady Flow in the Hanford Reach—The one-dimesional MASS1 model developed by Dr. Richmond is being used to simulate impacts of Priest Rapids Dam operations on the Hanford Reach of the Columbia River. Water elevations and temperatures simulated by

MASS1 str being used in conjunction with field studies to assess the effects of power peaking on fish stranding in the Hanford Reach.

Sediment Transport in the Lower Snake River—As part of an effort to protect and enhance salmon populations in the Snake River, the Corps of Engineers is considering an option to return the river to pre-dam conditions. Dr. Richmond is leading an assessment of sediment transport for the natural river option using the MASS1 and MASS2 models. A key feature of the work is the development of a probablistic analysis framework to allow decision makers to view the model results in the context of the historical hydrologic record.

Columbia Basin Unsteady Flow and Dissolved Gas Transport Modeling-- Dr. Richmond is leadig a team that is developing and applying unsteady flow and dissolved gas transport models (1-D MASS1 and 2-D MASS2) to the Lower Columbia and Snake River Systems for the Corps of Engineers Walla Walla and Portland districts. The models will be used to simulate system-wide dissolved gas levels in response to hourly operations (power generation and spill) at main stem dams. The FINS individual fish model is being used to assess the exposure and mortality effects of dissolved gas on salmonid populations in these studies.

SELECTED PUBLICATIONS

Richmond, M.C., W.A. Perkins, and T.D. Scheibe. 1998. Two-Dimensional Hydrodynamic, Water Quality, and Fish Exposure Modeling of the Columbia and Snake Rivers. Part I: Summary and Model Formulation. Draft Final Report submitted to U.S. Army Corps of Engineers, Walla Walla District. Battelle Pacific Northwest Division, Richland, Washington.

Richmond, M.C. and W.A. Perkins. 1998. Two-Dimensional Hydrodynamic, Water Quality, and Fish Exposure Modeling of the Columbia and Snake Rivers. Part 9:Tidal Reach. Draft Final Report submitted to U.S. Army Corps of Engineers, Walla Walla District. Battelle Pacific Northwest Division, Richland, Waston.

Hanrahan, T.P., D.A. Neitzel, and M.C. Richmond. 1998. Assessment of Drawdown from a Geomorphic Perspective using Geographic Information Systems: Lower Snake River, Washington. Final Report submitted to U.S. Army Corps of Engineers, Walla Walla District. Pacific Northwest National Laboratory, Richland, Washington.

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PROJECT RESPONSIBILITIES

Dr. Richmond will serve as lead investigator to refine and apply the hydraulic simulation models to the study area downstream of the Bonneville Project. His primary responsibilities will be to apply the model, implement any specific model output modifications needed for this task, supervise other staff working with the models, and reporting.

Section 10. Information/technology transfer

Sampling updates plus water depth and flow data will be provided to the Fish Passage Center for dissemination to the region via the Homepage on a weekly basis. The results from this project will be published in a annual report. Summaries of raw biological data will be available in a computerized data base. CWT recovery information will be available from the PSMFC data base. All data summaries and analysis produced by this project would be made available for use by the BPA funded Stream Net Project.

Congratulations!